Malware

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Malware

- Malicious code often masquerades as good software or attaches itself to good software
- Some malicious programs need host programs
  - Trojan horses, logic bombs, viruses
- Others can exist and propagate independently
  - Worms, automated viruses
- There are many infection vectors and propagation mechanisms
- Really all depends on intentions !!

Trojan Horses

- A trojan horse is malicious code hidden in an apparently useful host program
- When the host program is executed, trojan does something harmful or unwanted
  - Must be user tricked into executing the host program ?
- Trojans do not replicate
  - Main difference from worms and viruses, but today many trojans are spread by virus-like mechanisms

Viruses

- Virus propagates by infecting other programs
  - Automatically creates copies of itself, but to propagate, a human has to run an infected program
    - Self-propagating malicious programs are usually called worms
- Many propagation methods
  - Insert a copy into every executable (.COM, .EXE)
  - Insert a copy into boot sectors of disks
    - “Stoned” virus infected PCs booted from infected floppies, stayed in memory and infected every floppy inserted into PC
  - Infect TSR (terminate-and-stay-resident) routines
    - By infecting a common OS routine, a virus can always stay in memory and infect all disks, executables, etc.

Virus Techniques

- Macro viruses
  - A macro is an executable program embedded in a word processing document (MS Word) or spreadsheet (Excel)
  - When infected document is opened, virus copies itself into global macro file and makes itself auto-executing (e.g., gets invoked whenever any document is opened)
- Stealth techniques
  - Infect OS so that infected files appear normal
    - Used by rootkits (we'll look at them later)
  - Mutate, encrypt parts of code with random key

Stealth Techniques

- Mutation: virus has multiple binary variants
  - Defeats naïve signature-based detection
  - Used by the most successful (i.e., widespread) viruses
    - Tanked: 62 variants, SdDrop: 14 variants
- Aliasing: virus places its copies under different names into the infected host's sharing folder
  - "ICQ Lite .exe", "ICQ Pro 2003b.exe", "MSN Messenger 5.2.exe"

Propagation via Websites

- Websites with popular content
  - Games: 60% of websites contain executable content, one-third contain at least one malicious executable
  - Celebrities, adult content, everything except news
- Large variety of malware
  - But most of the observed programs are variants of the same few adware applications (e.g., WhenU)

Malicious Functionality

- Adware
  - Display unwanted pop-up ads
- Browser hijackers
  - Modify home page, search tools, redirect URLs
- Trojan downloaders
  - Download and install additional malware
- Dialer (expensive toll numbers)
- Keylogging

Drive-By Downloads

- Website “pushes” malicious executable to user’s browser with inline Javascript or pop-up window
  - Naive user may click “Yes” in the dialog box
- Can also install malicious software automatically by exploiting bugs in the user’s browser
  - 1.5% of URLs crawled in the Moshchuk et al. study
- Constant change
  - Many infectious sites exist only for a short time or change substantially from month to month
  - Many sites behave non-deterministically

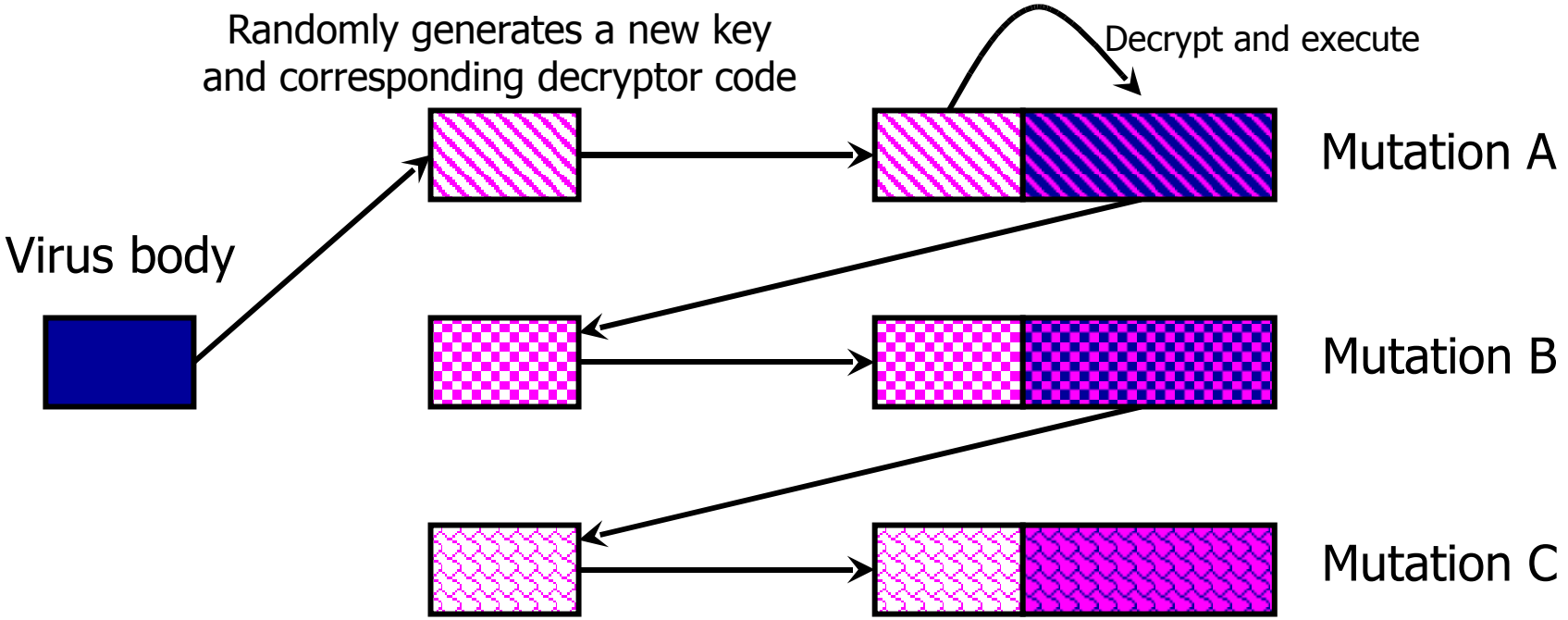
Polymorphic Viruses

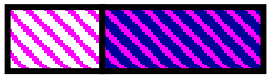
- Encrypted viruses: virus consists of a constant decryptor, followed by the encrypted virus body
  - Relatively easy to detect because decryptor is constant
- Polymorphic viruses: constantly create new random encryptions of the same virus body
  - Marburg (Win95), HPS (Win95), Coke (Win32)
  - Virus includes an engine for creating new keys and new encryptions of the virus body
    - Crypto (Win32) decrypts its body by brute-force key search to avoid explicit decryptor code
  - Decryptor can start with millions of NOPs to defeat emulation

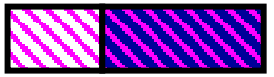
Anti-Virus Technologies

- Simple anti-virus scanners
  - Look for signatures (fragments of known virus code)
  - Heuristics for recognizing code associated with viruses
    - Polymorphic viruses often use decryption loops
  - Integrity checking to find modified files
    - Record file sizes, checksums, MACs (keyed hashes of contents)
    - Often used for rootkit detection (we'll see TripWire later)
- Generic decryption and emulation
  - Emulate CPU execution for a few hundred instructions, virus will eventually decrypt, can recognize known body
    - Does not work very well against mutating viruses and viruses not located near beginning of infected executable

Virus Detection by Emulation



To detect an unknown mutation  of a known virus  ,

emulate CPU execution of  until the current sequence of instruction opcodes matches the known sequence for virus body 

Metamorphic Viruses

- Obvious next step: mutate the virus body, too!
- Virus can carry its source code (which deliberately contains some useless junk) and recompile itself
  - Apparition virus (Win32)
  - Virus first looks for an installed compiler
    - Unix machines have C compilers installed by default
  - Virus changes junk in its source and recompiles itself
    - New binary mutation looks completely different!
- Mutation is common in macro and script viruses
  - Macros/scripts are usually interpreted, not compiled

Obfuscation and Anti-Debugging

- Common in worms, viruses, bots
- Goal: prevent analysis of code and signature-based detection; foil reverse-engineering
  - Insert garbage opcodes and change control structure
  - Different code in each instance
    - Effect of code execution is the same, but difficult to detect by passive analysis
  - Packed binaries
- Detect debuggers and virtual machines, terminate execution

Mutation / Obfuscation Techniques

- Same code, different register names
  - Regswap (Win32)
- Same code, different subroutine order
  - BadBoy (DOS), Ghost (Win32)
  - If n subroutines, then n! possible mutations
- Decrypt virus body instruction by instruction, push instructions on stack, insert and remove jumps, rebuild body on stack
  - Zmorph (Win95)
  - Can be detected by emulation because the rebuilt body has a constant instruction sequence

Mutation Engines

- Real Permutating Engine/RPME, ADMutate, etc.
- Large set of obfuscating techniques
  - Instructions are reordered, branch conditions reversed
  - Jumps and NOPs inserted in random places
  - Garbage opcodes inserted in unreachable code areas
  - Instruction sequences replaced with other instructions that have the same effect, but different opcodes
    - Mutate SUB EAX, EAX into XOR EAX, EAX or

      PUSH EBP; MOV EBP, ESP into PUSH EBP; PUSH ESP; POP EBP
- There is no constant, recognizable virus body!

Example of Zperm Mutation

- From Szor and Ferrie, “Hunting for Metamorphic”

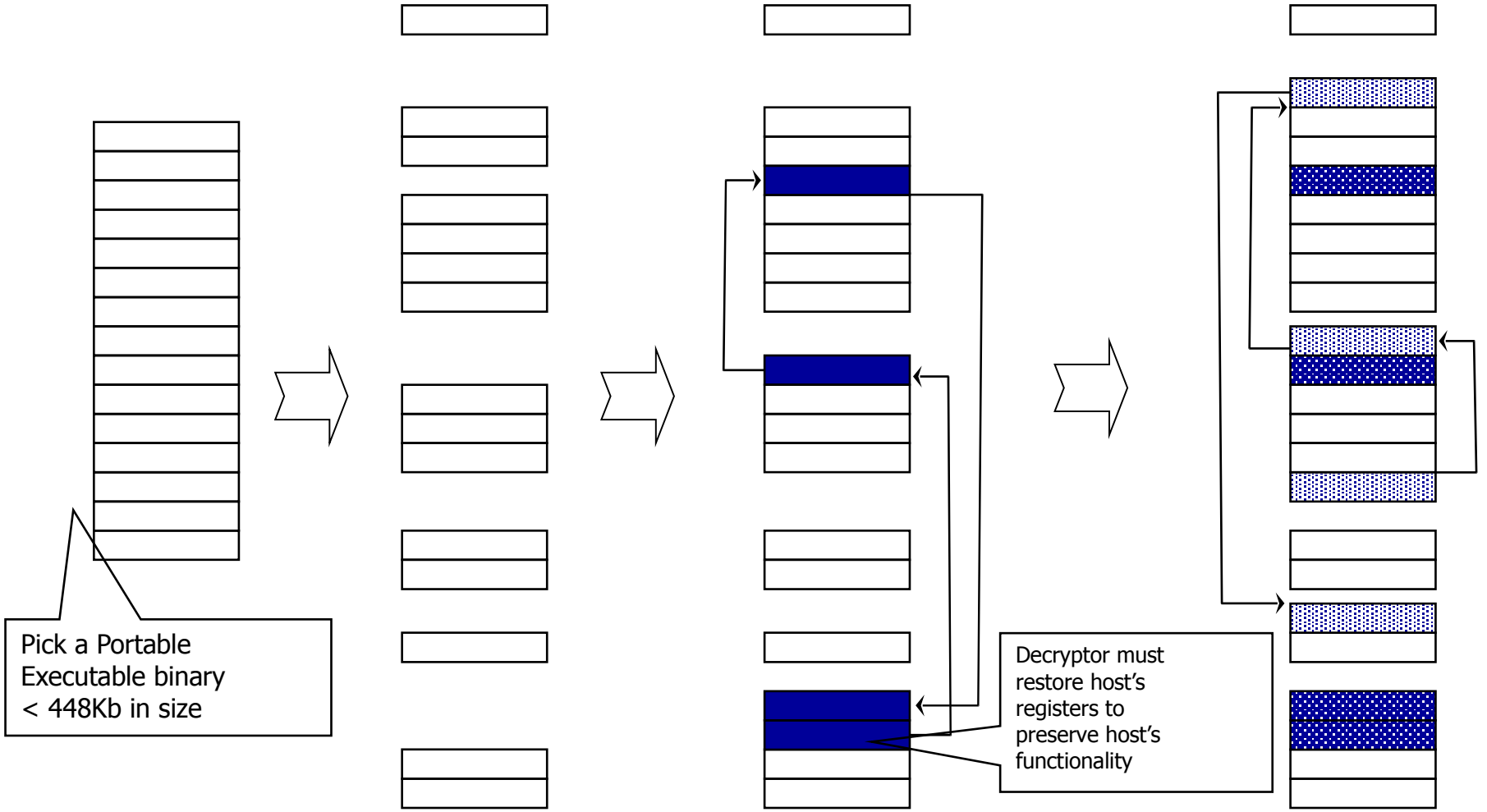
Putting It All Together: Zmist

- Zmist was designed in 2001 by Russian virus writer Z0mbie of “Total Zombification” fame
- New technique: code integration
  - Virus merges itself into the instruction flow of its host
  - “Islands” of code are integrated into random locations in the host program and linked by jumps
  - When/if virus code is run, it infects every available portable executable
    - Randomly inserted virus entry point may not be reached in a particular execution

MISTFALL Disassembly Engine

- To integrate itself into host's instruction flow, virus must disassemble and rebuild host binary
  - See overview at *http://vx.netlux.org/lib/vzo21.html*
- This is very tricky
  - Addresses are based on offsets, which must be recomputed when new instructions are inserted
  - Iterative process: rebuild with new addresses, see if branch destinations changed, then rebuild again
    - Requires 32MB of RAM and explicit section names (DATA, CODE, etc.) in the host binary – doesn't work with every file

Simplified Zmist Infection Process



Disassemble, insert space for new code blocks, generate new binary

Insert mutated virus body

- Split into jump-linked "islands"
- Mutate opcodes (XOR↔SUB, OR↔TEST)
- Swap register moves and PUSH/POP, etc.

Encrypt virus body by XOR (ADD, SUB) with a randomly generated key, insert mutated decryptor

How Hard Is It to Write a Virus?

- 2268 matches for “virus creation tool” in CA’s Spyware Information Cente
  - Including dozens of poly- and metamorphic engines
- OverWritting Virus Construction Toolkit
  - "The perfect choice for beginners”
- Biological Warfare Virus Creation Kit
- Vbs Worm Generator (for Visual Basic worms)
  - Used to create the Anna Kournikova worm
- Many others
- http://www.youtube.com/watch?v=RGTM-WZnQ
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Home reading

www.symantec.com/avcenter/reference/hunting.for.metamorphic.pdf